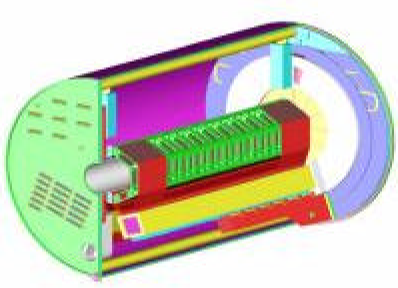


MVD in Run 4

9-Jul-2003

Hubert van Hecke

John P. Sullivan

The physics problem:

The MVD produces background, especially in the low mass region for e+e- pairs. Thickness 0.76% rad. length for one layer of Si.

I do not think there is any other reason which could justify removing a working MVD from PHENIX.

The immediate practical problem:
Indecision wastes time and money

Possible courses of action:

1) Install the MVD if it is working (this is not a new problem)
2) Install part of the MVD (e.g. the pads only)
3) Install all of the MVD for part of the run
4) Do not install the MVD

We want (our preferred plan):

1) Agreement that the complete MVD will be installed if it is proven to work.
2) A 2nd PHENIX decision point (on whether or the the MVD works, not on whether or not to install it if it does) ~ 1 month before run.
3) A definition of “working”. I suggest: signal to noise around design specs (10/1) with pedestals stable on the scale of days.

If we can’t have that, we would like a decision on the alternatives.

We do not want:

1) Indecision which causes a lot of pointless work – we need a “go/no go” decision soon (~ a week).
2) To install parts of the MVD which are not working.
3) A decision to regularly rearrange the MVD between runs.

Alternative 1:

We could reconfigure the MVD to install only the pads.

The pads worked well in run 3.

This would remove almost all of the e+- background associated with the MVD while retaining some ability to measure multiplicity, reaction plane, and space-points on some muon tracks.

Some structural materials, outside the acceptance, would remain.

We could make this change in ~ 1 month.

For this reason, a 2nd meeting to decide whether or not the MVD barrel “works” should be ~1 month before the run.

Alternative 2:

Last year's MVD review by PHENIX (closeout report: http://www.phenix.bnl.gov/phenix/WWW/p/draft/seto/mvdreview/) suggested a another alternative:
"… to remove the MVD for some period (for example two weeks) during Au+Au data taking giving the entire period to minimum bias triggers. …" This was given as a possible compromise, not a recommendation.

This alternative would also require a second decision point ~1 month before the run – because we still would not propose to install the barrel if it did not work well enough.

It is not practical to quickly (<few weeks) install the MVD. Debugging time is needed. It can be removed in 1 shift or less.

A few facts from run 3:

1) Most of the MVD readout worked well. The causes of most remaining problems are understood and repairable.
2) The MVD pad detectors worked well – meaning low noise and stable pedestals.
3) Some of the strip detectors worked well, but most were noisy.
4) We believe we know the cause of the noise in the barrel and expect to fix it later this month.

MVD-specific readout chain for pads vs. strips

Pads		Strips	
Pad detector (6-25 mm²)		Strip detector (25-40 mm²)	
	We think the problem is here	Kapton cable	← Al-mylar between cables
MCM	Same part	MCM	
Daughter board	Same schematic, different layout	Power/comm. board	
Motherboard		Motherboard	
cable	Same parts	cable	
DCIM board		DCIM board	

22/22 noise OK

15/66 noise OK

Noise in the barrel – what can we do?

The noise in the barrel seems to be associated with the shields (grounded aluminized-mylar foils) between the kapton cables.

Almost all of the "good" channels in the barrel are on the outer bottom layer.

We plan to disassemble one half of the MVD and do some tests on the grounding, etc of these foils at the end of July. We may decide to remove them altogether – the noise was much better is most channels before we added them.

Why should you care if the MVD is there?

Some answers:

- Precision vertex (~0.1 mm)
- Multiplicity
- reaction plane
- fluctuations
- $dN/d\eta$ and $dN/d\eta/d\phi$
- tracking info for some tracks?

We are asking PHENIX to decide whether the complete MVD should be installed for run 4 if it works. We are further proposing that whether or not it works be decided after it works (or does not). A long series of current performance plots does not seem relevant to this decision. However, a few slides follow.

Summary of vertex resolutions

	p+p	d+A	Au+Au
σ_{BBC}	~1.6	0.7-1.6	0.7 cm
σ_{PC}	~1.2	0.5-1.2	0.5 cm
σ_{ZDC}	>10?	~10	2.6 cm
σ_{MVD}	0.1	0.07	<0.65 cm

The extra slides following the summary describe the origin of these various numbers – but we will not show them unless someone insists on it.

Numbers in blue are from simulations, others are measured, or at least estimated from data.

Vertex from other algorithms?

We should be able to find the vertex from the variations in the signal size (ADC value) vs. the angle of incidence:
Dz = distance from vertex = (5cm) $[(\mathrm{ADC}/1\ \mathrm{mip})^2 - 1]^{1/2}$

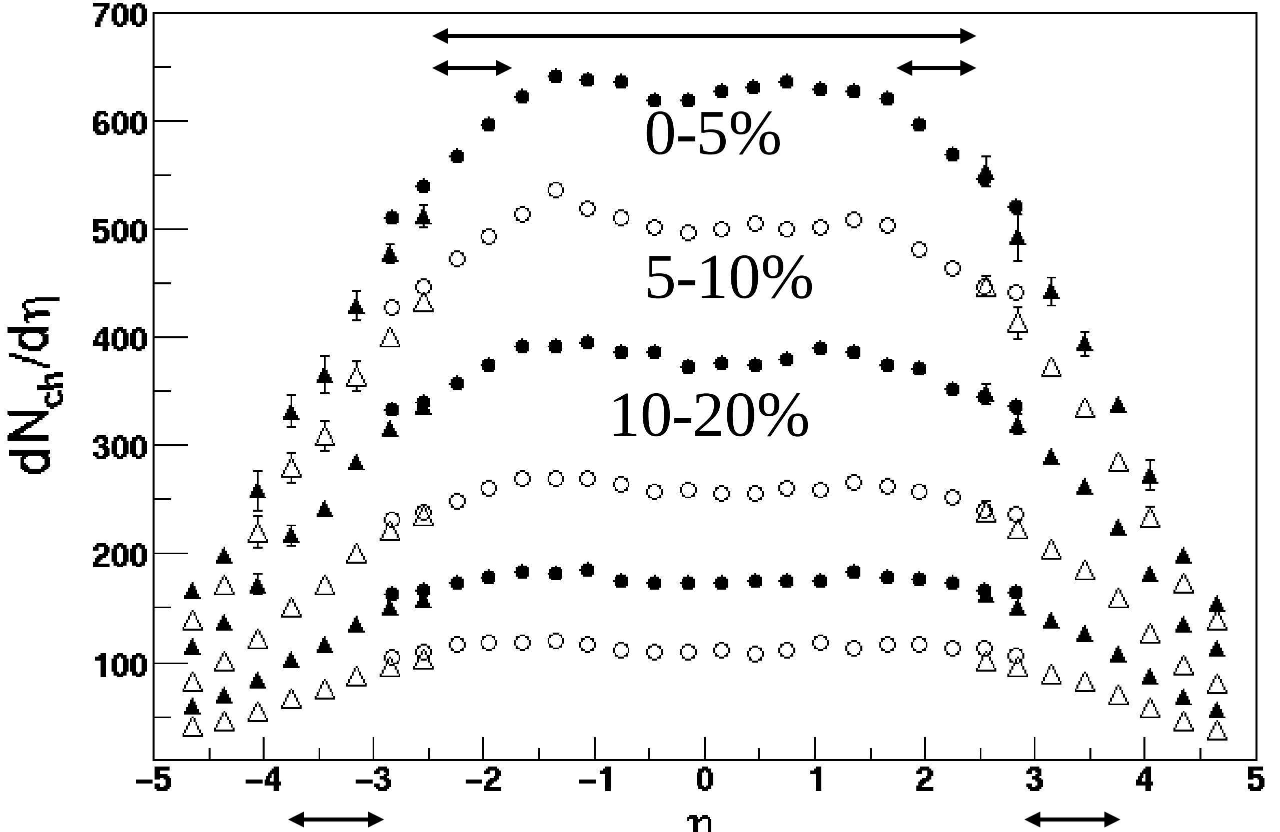
In simulations, algorithm can find the vertex to within a few cm (good enough for improving J/Ψ resolution) in events with very few hits in the MVD barrel.

Could be important for pp, pA, dA, where is might recover events without a BBC vertex.

MVD h coverage

MVD: -2.5 < η < 2.5, Roughly 5 times BBC multiplicity.
Pad detectors alone: -1.8 < |η| < 2.5, Mult ~ 800 in (6048 chan)

AuAu
200 GeV,
Brahms
(PRL
2002)



BBC: 3 < | η | < 3.9 , Mult. ~350 * 0.9 * 2 = 630 (in 128 chan.)

van Hecke/Sullivan

Muons: -2.2<η<-1.2, 1.2<η<2.4

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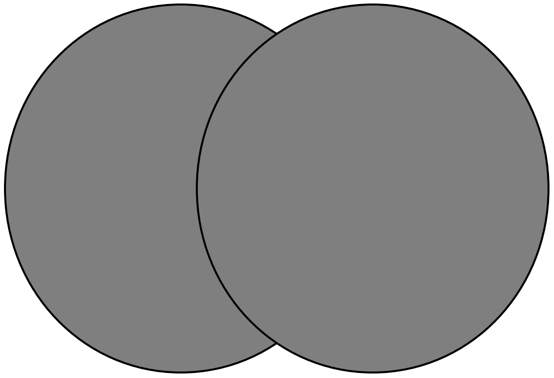
Reaction plane



The MVD should be able to make good measurements of the reaction plane in AA collisions.

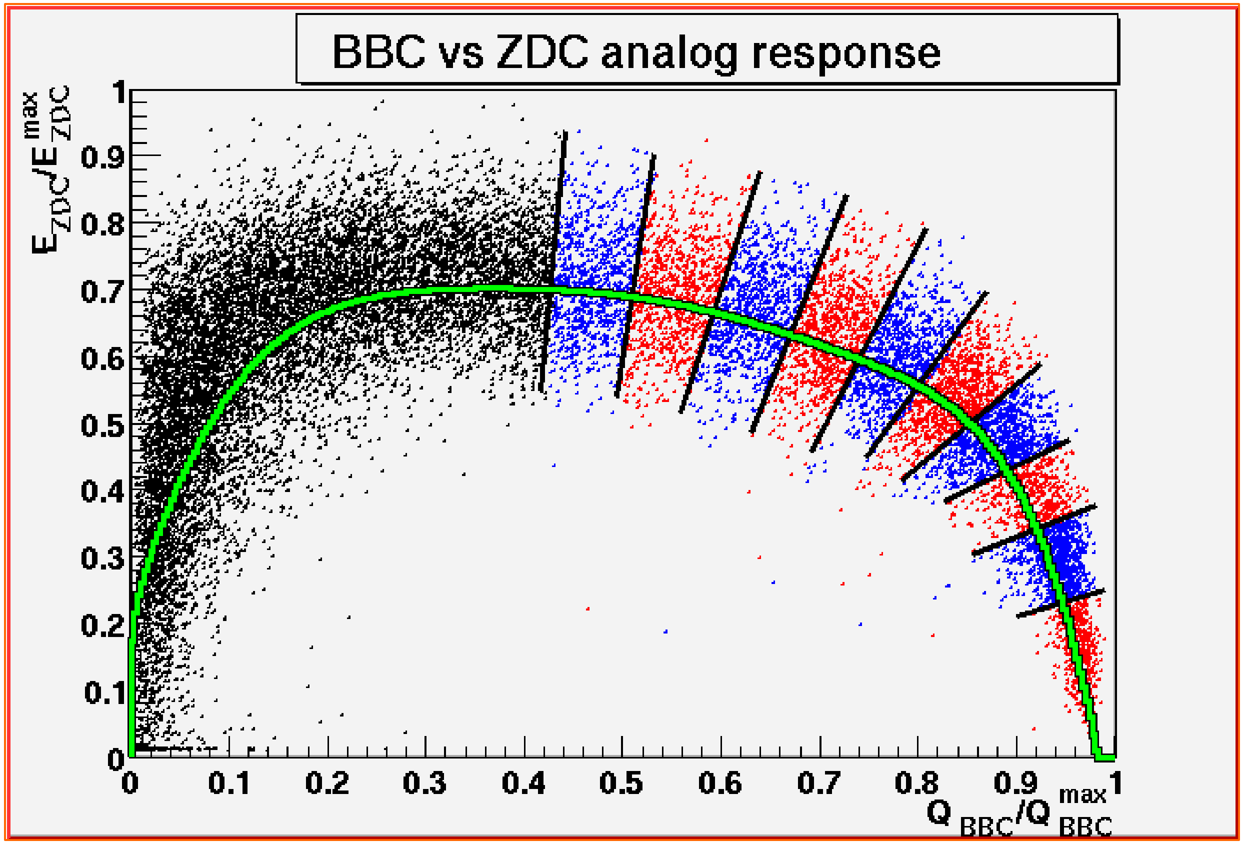
It sees ~5 times the number of particles as the BBC (with more channels).

Pad detectors by themselves have ~25% more particles than BBC in ~47 times as many channels.

MVD and BBC acceptance do not generally overlap – so these augment current BBC capabilities.

This gives another interesting way to look at jet suppression and J/Ψ suppression vs. the length of excited matter traversed.

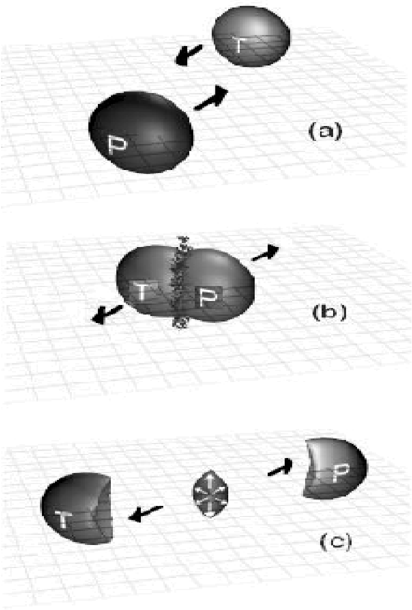
Centrality – now



ZDC/ZDC max

BBC/BBCmax

2R ← impact parameter ← 0



van Hecke/Sullivan

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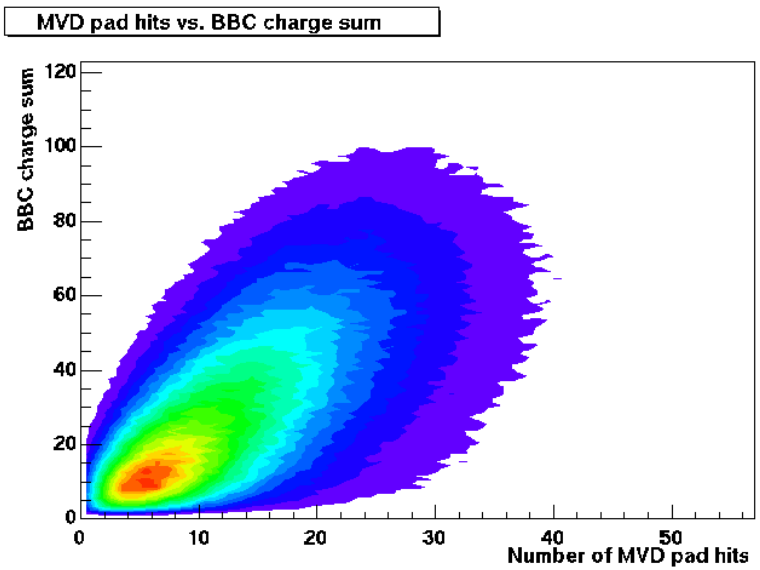
Centrality – with the MVD ?

BBC charge sum

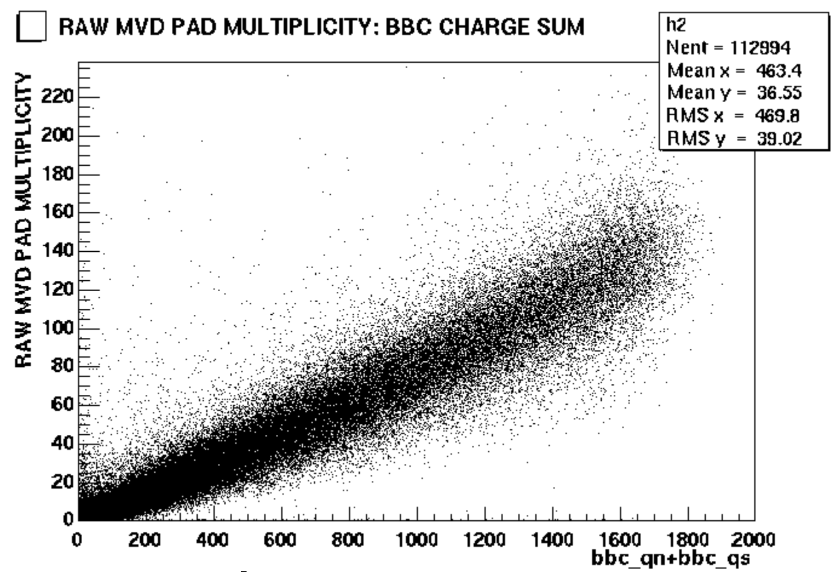


Run-3 d+Au

MVD pad hits

Year-2 Au+Au:

MVD pad mult



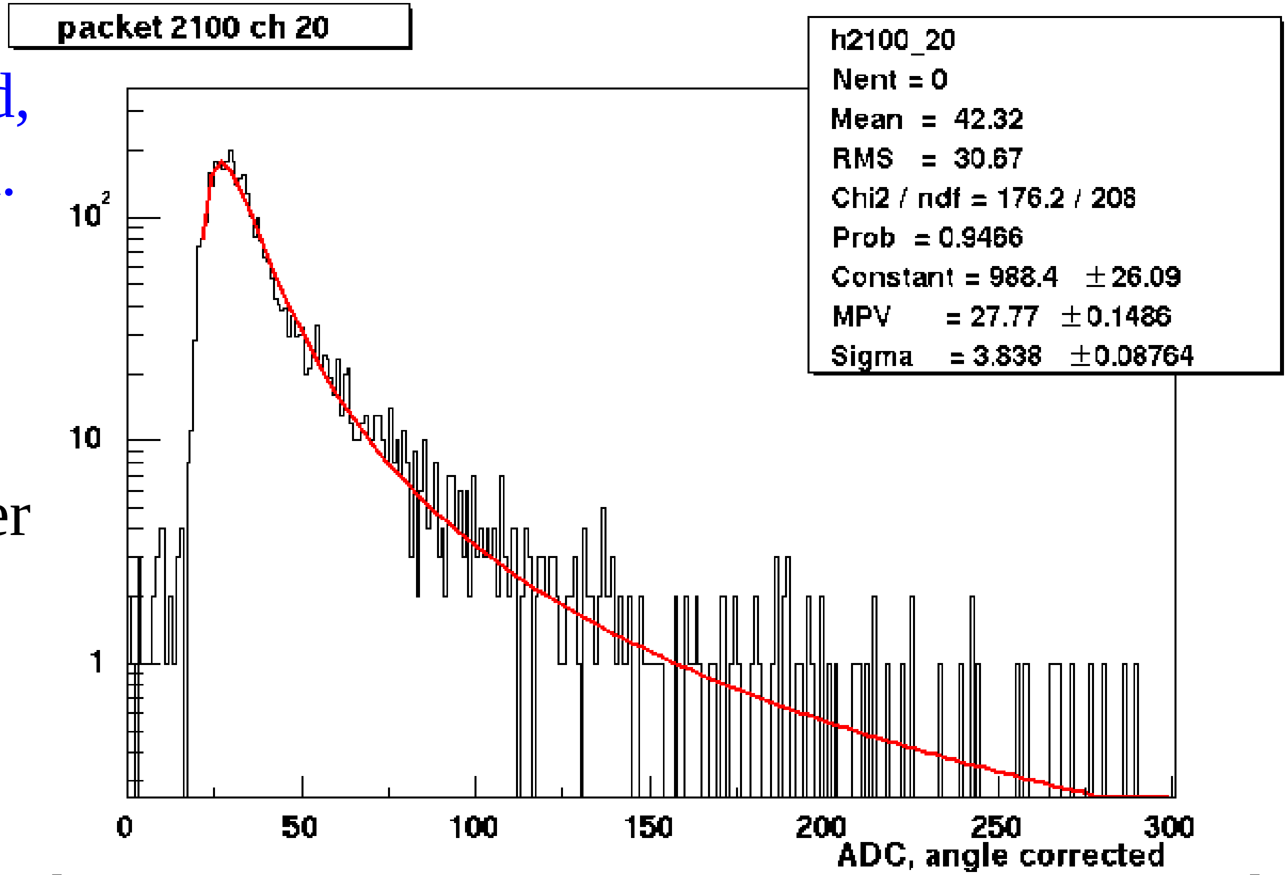
BBC charge sum

van Hecke/Sullivan

Landau fit to sample MVD pad detector channel

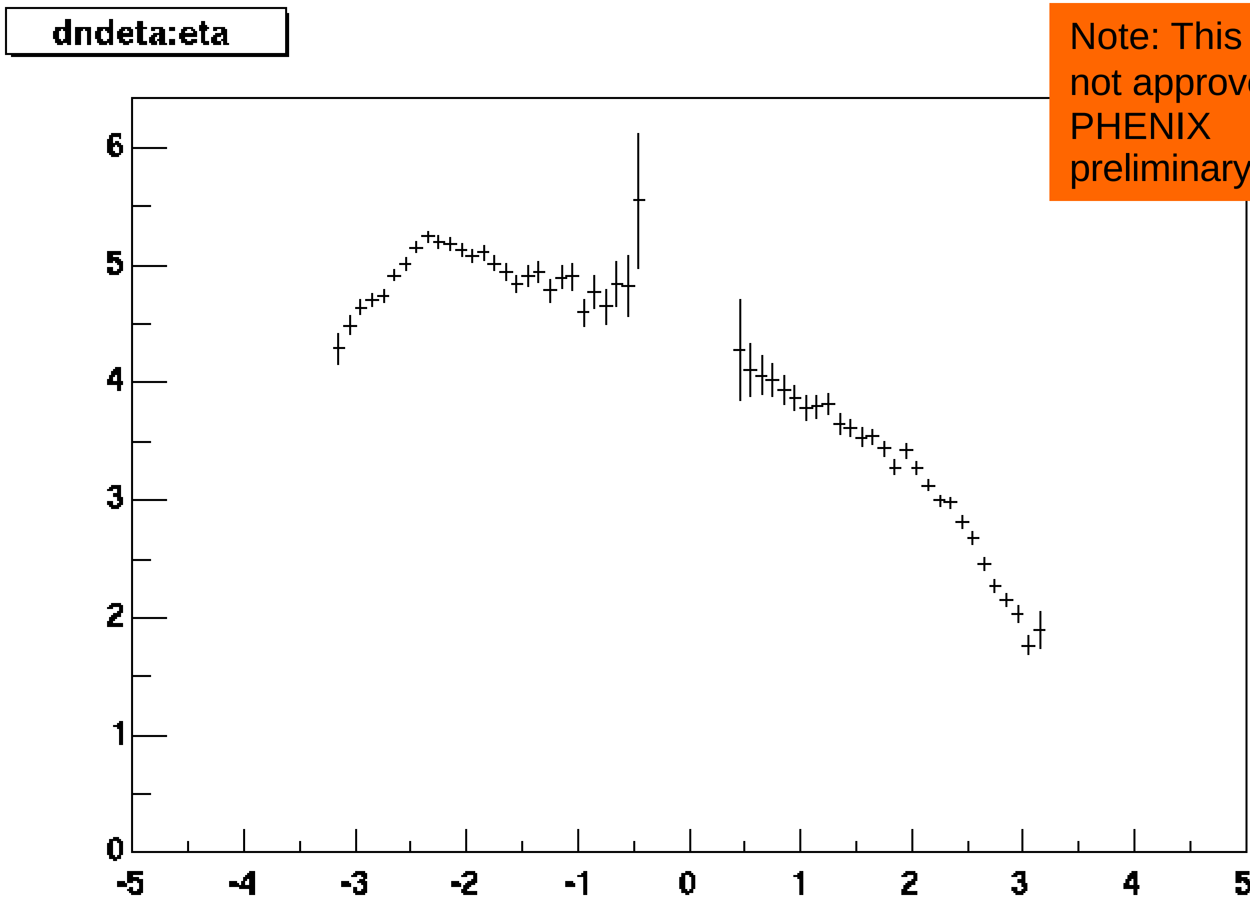
Plot is from Sangsu Ryu (Yonsei) – d+Au

Resolution is good,
Landau fit is good.



Maybe not unrealistic:
Pad detectors cover $\sim 1.8 < \eta < \sim 2.5$ (depending on z_{vertex}) – if we can consistently keep this resolution, maybe we can give a point on some muon arm tracks

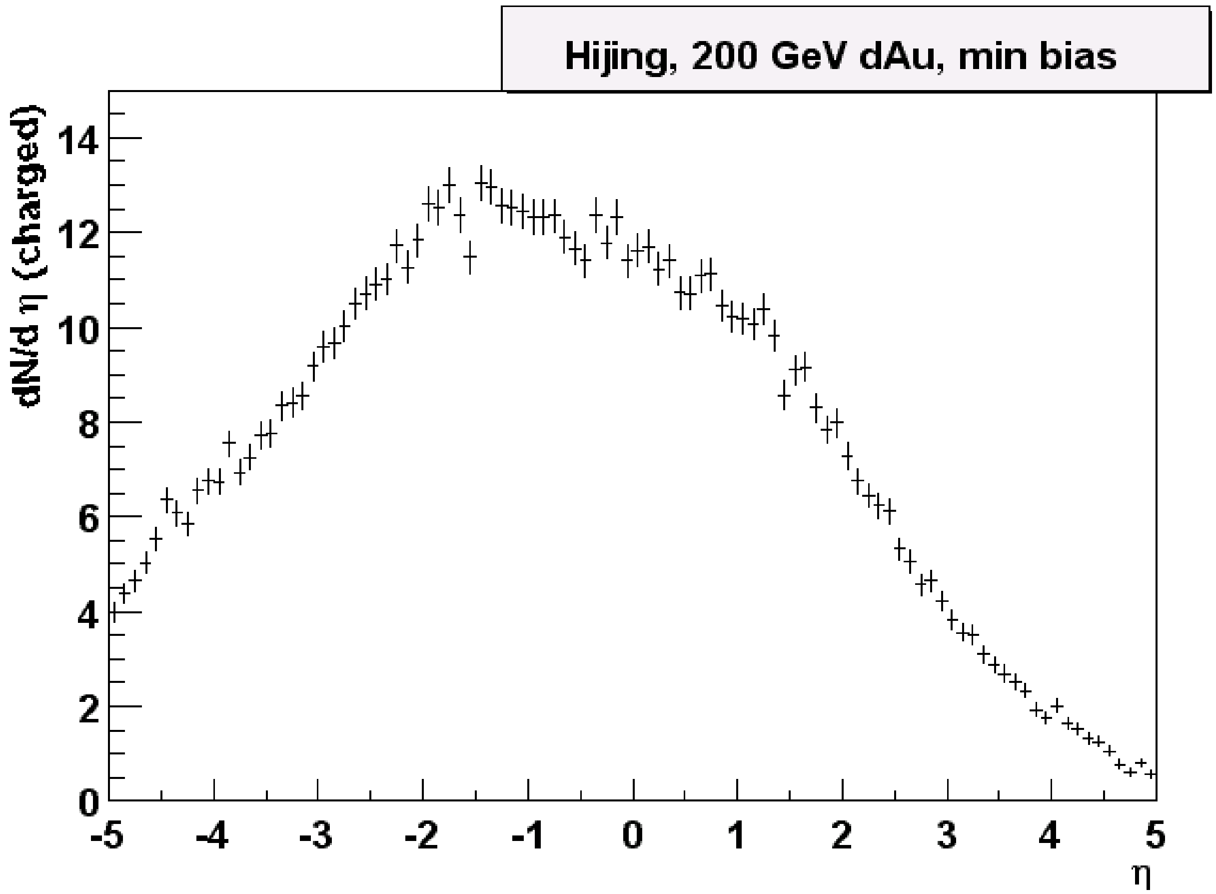
d+Au dN/dh from SangSu Ryu (from MVD pads)



Note: This plot is not approved as PHENIX preliminary

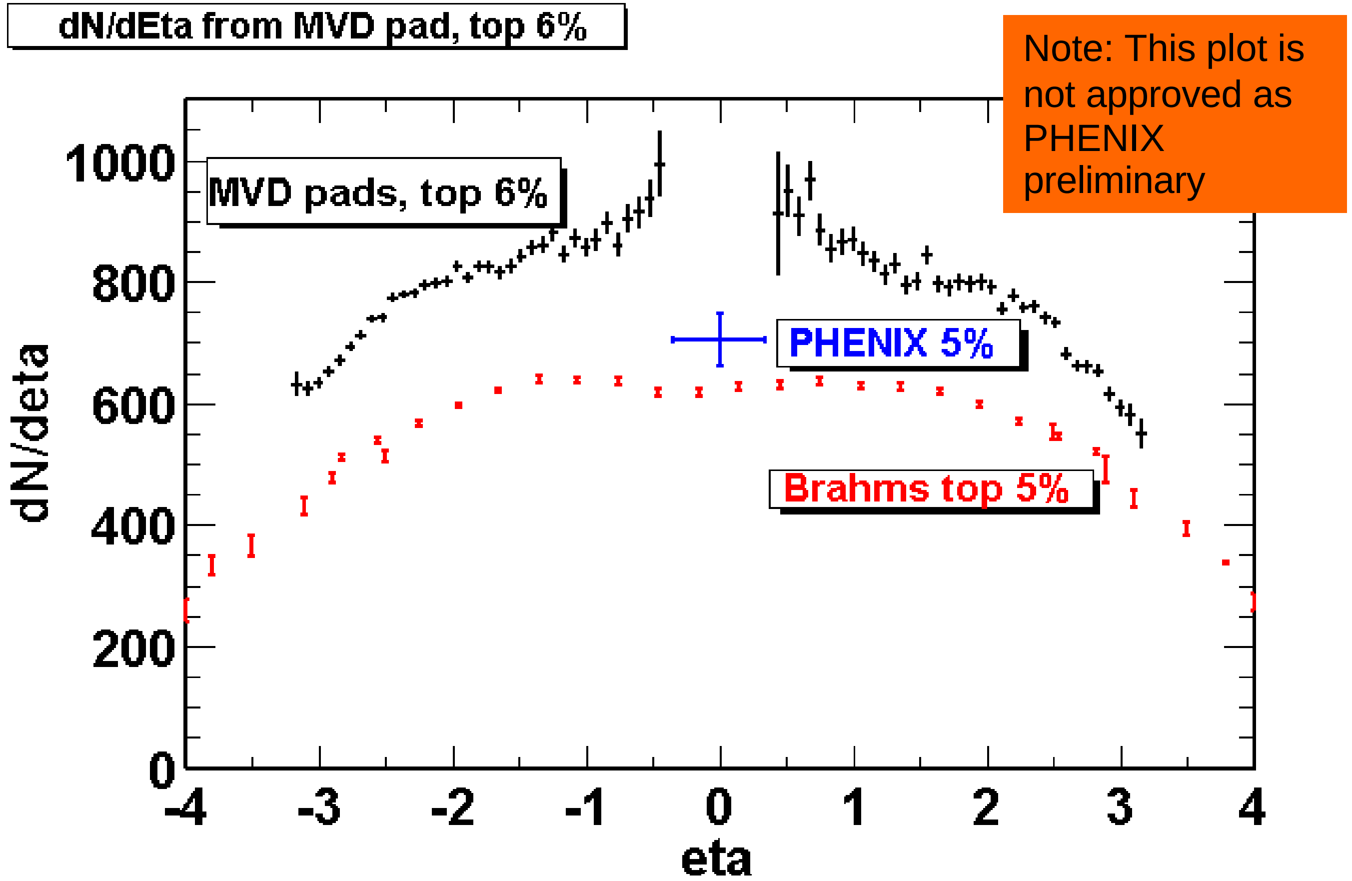
Minimum bias d+Au, using pad detectors, not “rigorously checked for possible programs bugs. So there is plenty of possibility for improvement. It also needs serious simulation efforts.” -- from SangSu’s email 2-Jun-2003.

Hijing d+Au dN/dη



Au+Au: MVD dN/dh

This plot comes from the work of Sangsu Ryu and Ju Kang at Yonsei. dN/dη is calculated from the MVD pads which had the best resolution in the year-2 run.



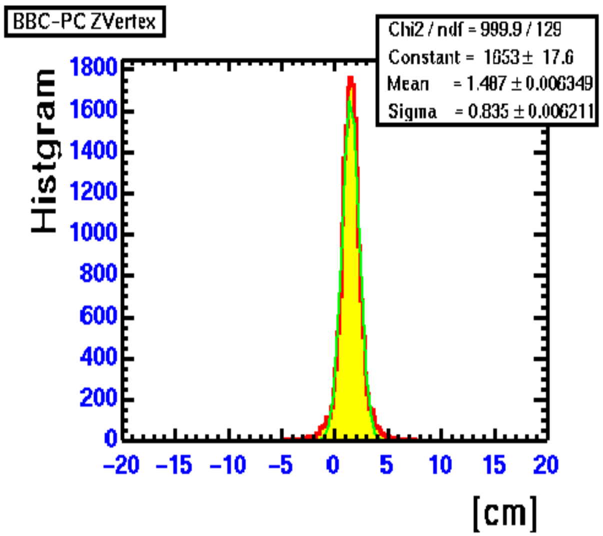
Summary

MVD should be able to improve vertex resolution and vertex finding efficiency in lower multiplicity events.

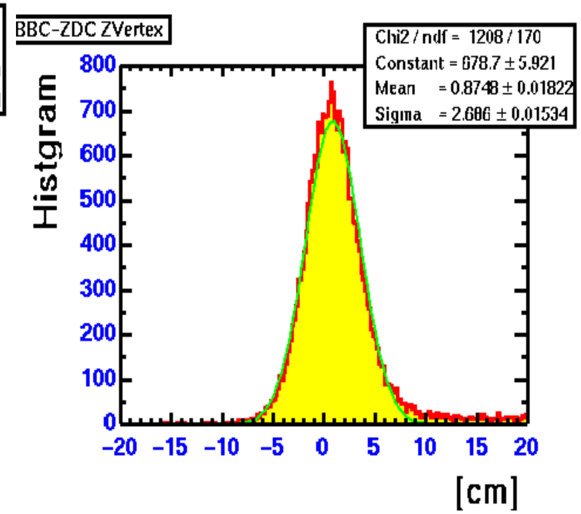
I believe that measurements of the reaction plane will add a lot to the PHENIX physics program – the MVD can make improve these.

For us, the worst decision is no decision.

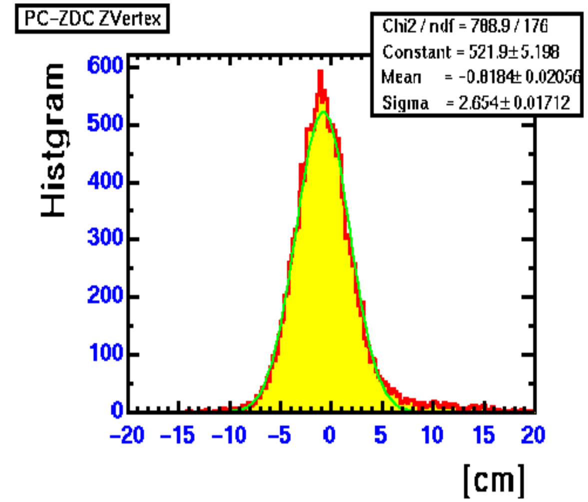
Resolution: RUN2 (Au+Au)



BBCZ - PCZ



BBCZ - ZDCZ



PCZ - ZDCZ

$$S^{2}_{BBC-PC} = S^{2}_{BBC} + S^{2}_{PC}$$

$$S^{2}_{BBC-ZDC} = S^{2}_{BBC} + S^{2}_{ZDC}$$

$$S^{2}_{ZDC-PC} = S^{2}_{ZDC} + S^{2}_{PC}$$

Plots from Tomoaki Nakamura -- Phenix focus talk.

My solutions to the equations on the previous slide

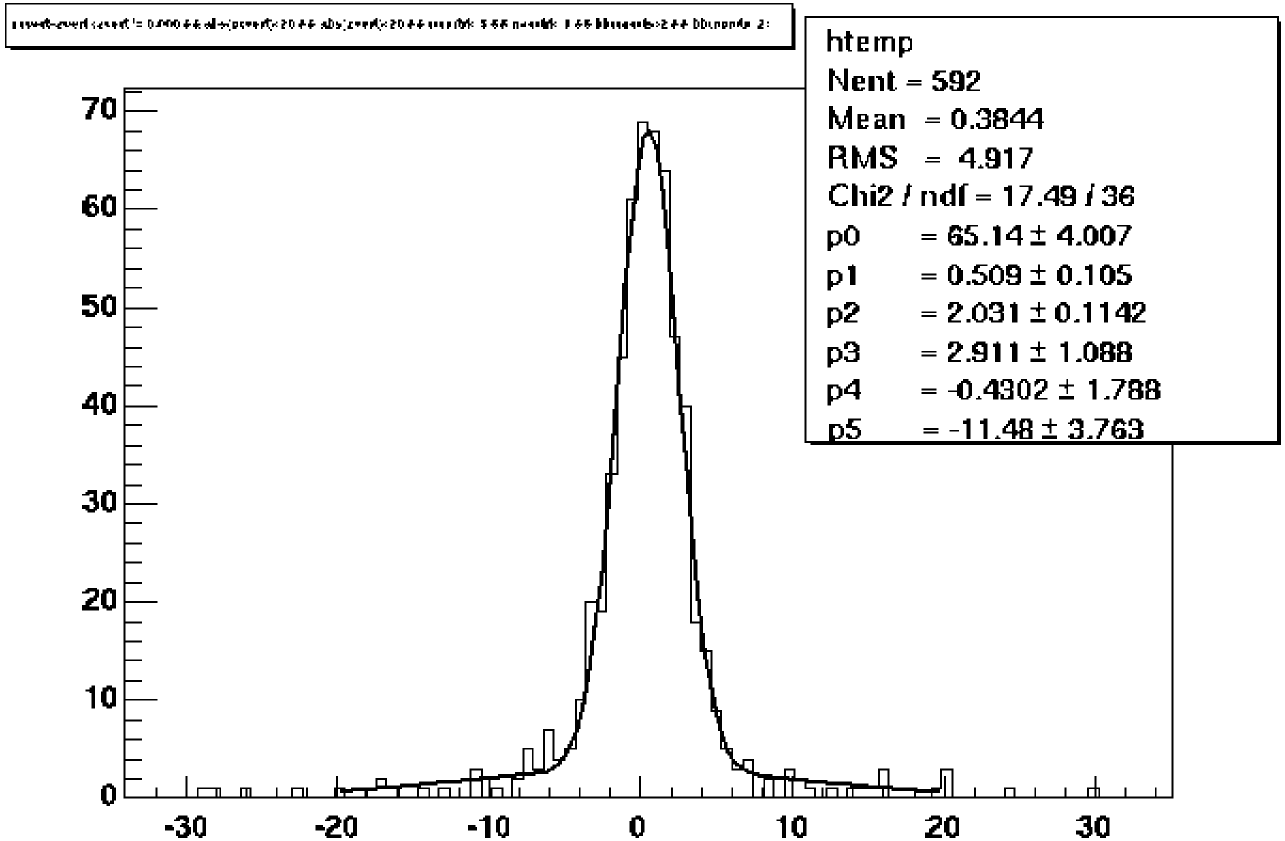
Au+Au data, run 2

σ_{BBC} = 0.66 +- 0.05 cm
σ_{PC} = 0.51 +- 0.06 cm
σ_{ZDC}=2.60 +- 0.01 cm

I assume this is for central events

Resolution of other detectors

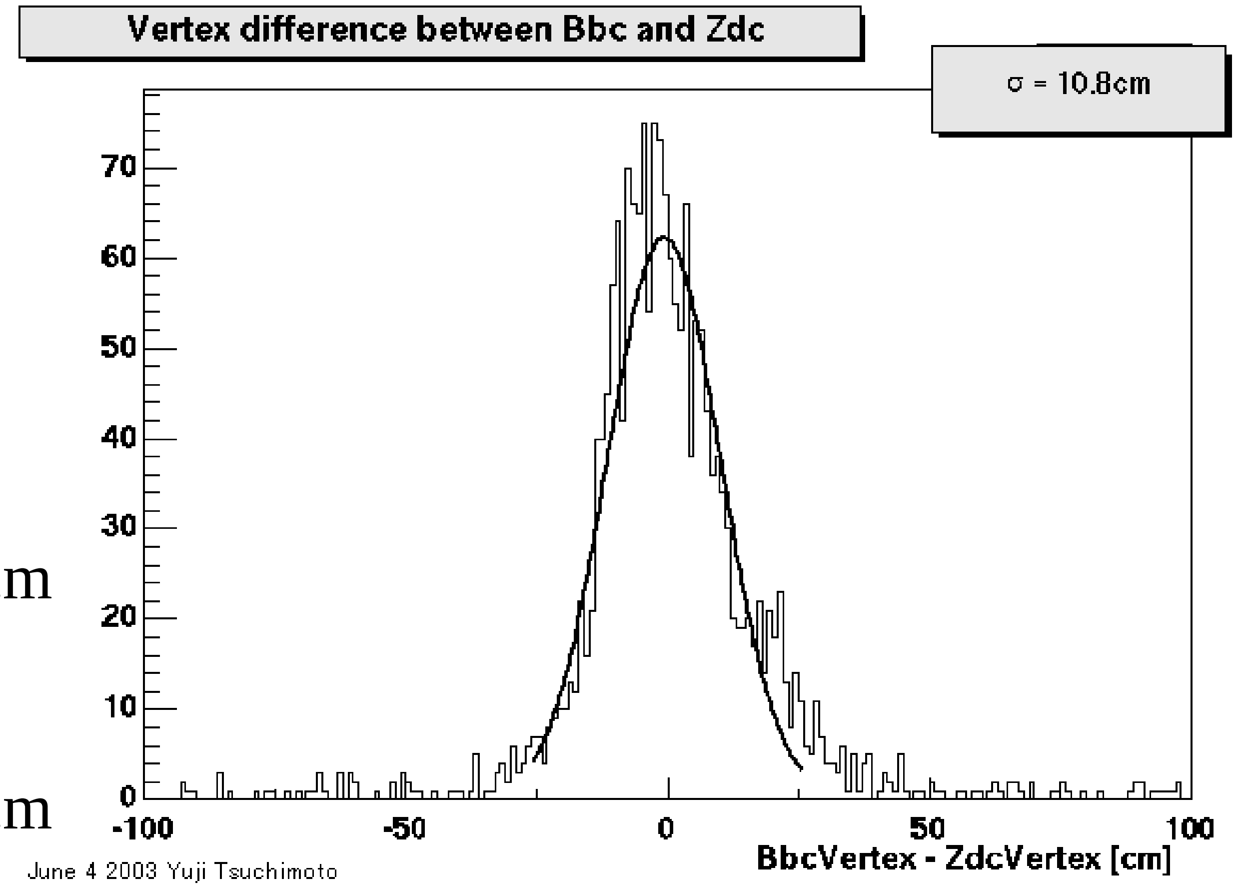
From David S,
pp run2 BBC-PC
vertex
difference
Width of narrow
Gaussian
is about 2 cm --
versus 0.835 cm in
AuAu.



Guess that both PC and BBC get worse by the same factor (vs. Au+Au) – σ_{BBC} ~ 1.6 cm and σ_{PC} ~ 1.2 cm. Good enough – it is only the efficiency (and tails on distribution) we need to worry about.

dAu – BBC – ZDC vertex difference

Plot from
Yuji Tsuchimoto
(Hiroshima)



d+Au:

$\sigma_{\mathrm{BBC\text{-}ZDC}}$ = 10.8 cm

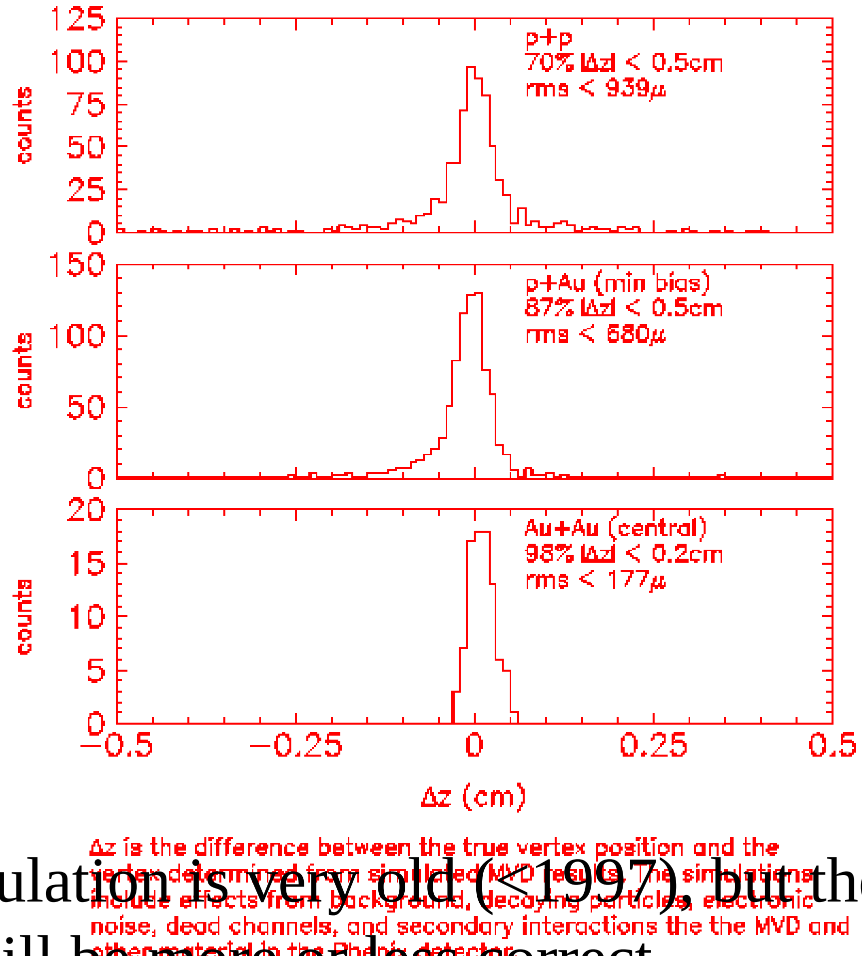
Au+Au:

$\sigma_{\mathrm{BBC\text{-}ZDC}}$ = 2.69 cm

Assume BBC vertex resolution for d+Au is between p+p:
σ_{BBC} (Au+Au) ~ 0.7 cm and σ_{BBC} = 1.6 cm (guestimated p+p) –
Implies ZDC resolution for d + Au ~ 10 cm.

Simulated MVD efficiency and resolution

ε= 70%
rms = 939μ



pp

ε= 87%
rms = 680μ

pAu

ε= 98%
rms = 177μ

AuAu
(central)

This simulation is very old (<1997), but the basic result should still be more or less correct.

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From Shinichi Esumi

-- Simulation with rqmd2.4 at Au+Au 200GeV.

-- Resolution is worse than in reality because the flow (v2) is smaller in this generator and he did not apply the pt weighting for the central arm.

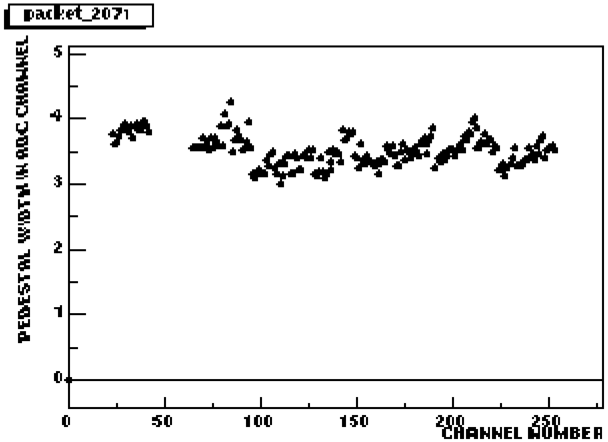
-- Can still take the factor how much we might gain with different configurations.

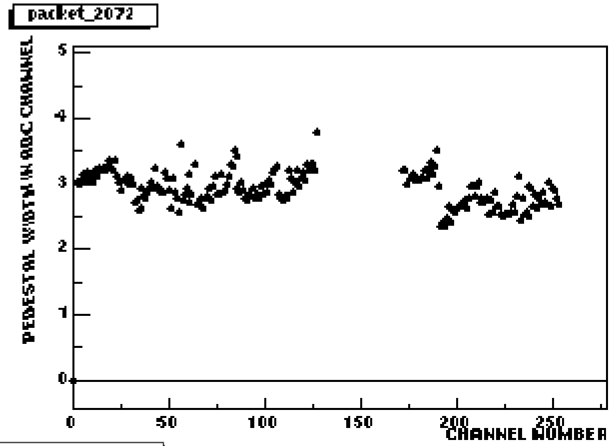
-- Resolution is for mid-central collisions.

Configuration:	coverage:	$\langle \cos^2(\text{calc.-true}) \rangle$	
combined bbc	$\lvert\eta\rvert = [3.0\text{-}4.0]$	0.22	(62 deg)
full central arm	$\lvert\eta\rvert < 0.35$	0.16	(66 deg)
hexagon	$\lvert\eta\rvert < 2.5$	0.42	(49 deg)

my guess: There are about 5 times as many particles in the MVD (vs BBC), so resolution will be ~ sqrt(5) better.

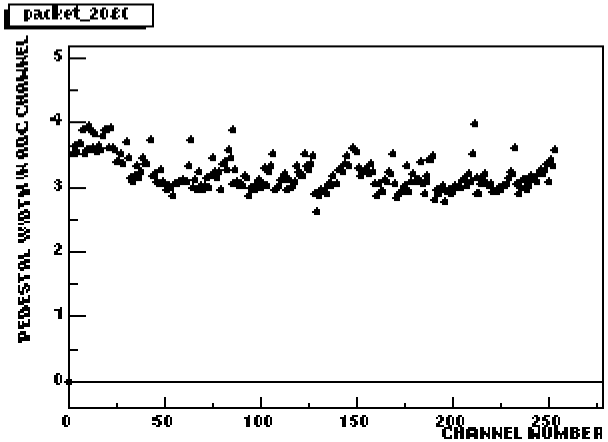
MVD pad pedestal

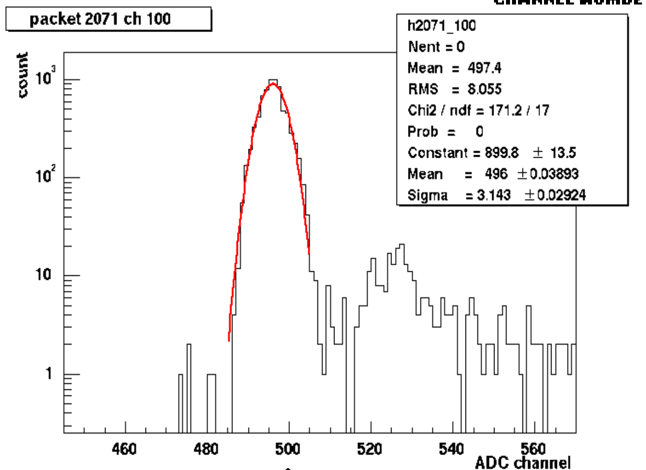




work by
Sangsu Ryu

3 good pad
detectors



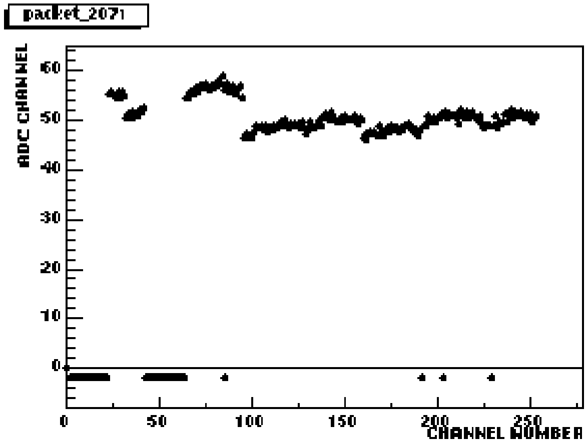


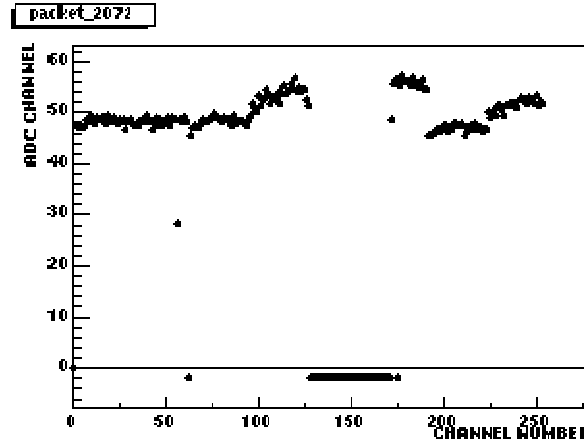
Year 2
Au+Au

Signal/noise ~ 45/4 ~ 11

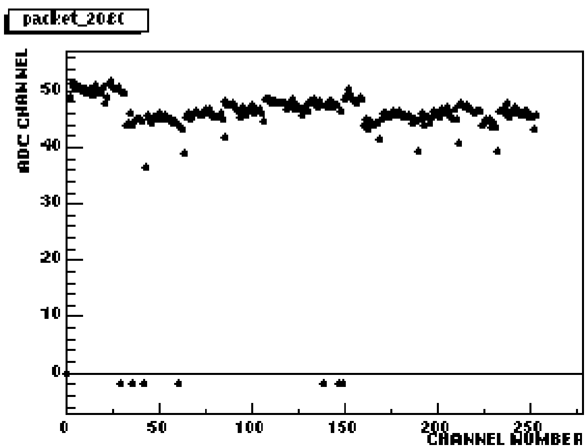
Pedestal

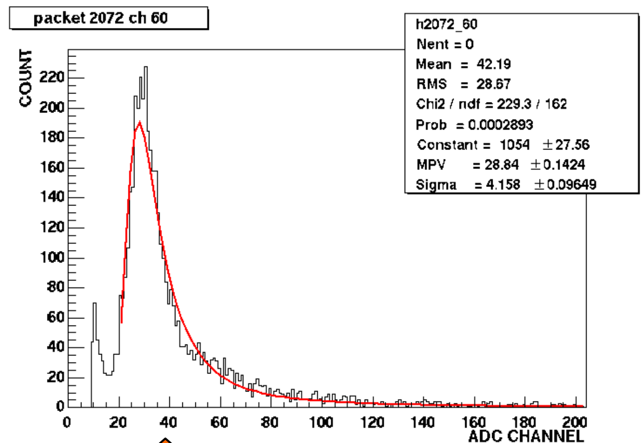
MVD pad mip distribution





Mean ADC corrected for incident angle, ~same for all chans.





Work from Sangsu Ryu/Yonsei

MIP signal, corrected for indent angle
Shows Landau distribution

From Ken Barrish

--Work from Wei in 2000.
--Fairly detailed simulation of the MVD response

pulse height cut plus a 10 deg separation cut rejects:
68% of the Dalitz decay electrons
75% of the beam pipe conversion electrons
While keeping 78% of signal electrons from charm and bottom.

Useful for a ΔG measurement using single electrons

Wei's PWG talk on Sep 14th, 2000:
http://www.phenix.bnl.gov/phenix/WWW/trigger/pp/c-arm/mtg000914/Wei/index.html
(main result for Dalitz/conversion rejection is on page 12)

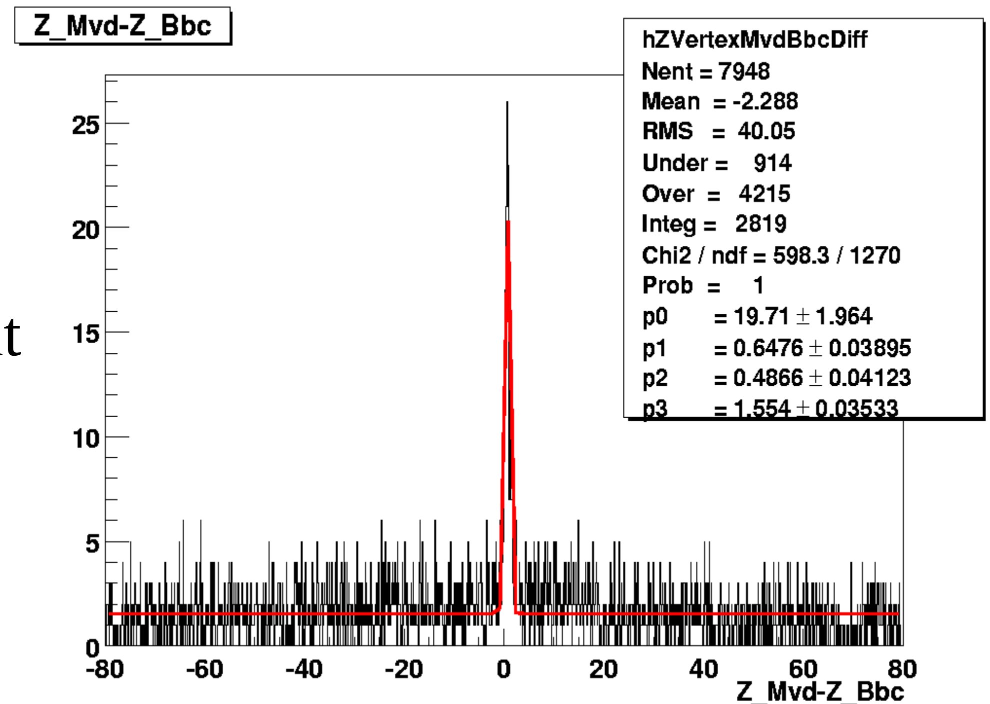
Mainly relevant for pp, pA collisions

Precision vertex

The vertex finding in the MVD did not work very well in year-2, but it sometimes found the vertex (difference between MVD-BBC):

From "standard" algorithms, $\sigma_{MVD} \sim 100$ μm

Needed ~5 particles to hit Inner+outer layer of MVD (1/3 of azimuth) to find the vertex – implies total multiplicity ~15.



Width of narrow peak ~0.65 cm, ~same as BBC resolution, implying $\sigma_{MVD} << \sigma_{BBC}$ (as expected)